

$$3. \quad d_0 = 15 \times 10^{-2} \text{ m} \quad d_1 = 30 \times 10^{-2} \text{ m} \quad C_d = 0.64$$

$$y = 50 \times 10^{-2} \text{ mHg} \quad Q = ?$$

$$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4} = 0.01767 \text{ m}^2 \quad S_{n_1} = 13.6$$

$$S_0 = 0.9$$

$$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4} = 0.0707 \text{ m}^2$$

$$H = 50 \times 10^{-2} \left[ \frac{13.6}{0.9} - 1 \right]$$

$$H = y \left[ \frac{S_{n_1} - 1}{S_0} \right]$$

$$H = 7.075 \text{ m}$$

$$Q = \frac{C_d A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}} = \frac{0.64 \times 0.0176 \times 0.0707 \sqrt{2 \times 9.81 \times 7.05}}{0.0707^2 - 0.0176^2}$$

$$Q = \underline{\underline{0.137 \text{ m}^3/\text{s}}}$$

$$4. \quad y = 170 \text{ mmHg} = 170 \times 10^{-3} \text{ mHg}$$

$$S_g \text{ of mercury} = 13.6 \text{ kg}$$

$$S_g \text{ of sea water} = 1.026$$

$$H = y \times \frac{S_{n_1} - 1}{S_0}$$

$$V = \sqrt{2gh}$$

$$V = \sqrt{2 \times 9.81 \times 2.08}$$

$$V = \underline{\underline{6.39 \text{ m/s}}}$$

$$H = 170 \times 10^{-3} \times \left( \frac{13.6 - 1}{1.026} \right)$$

$$H = 2.08 \text{ m}$$

$$5. \quad \text{Actual flow rate } Q = 5 \text{ dm}^3/\text{min} = 8.33 \times 10^{-5} \text{ m}^3/\text{sec}$$

$$P = 15 \text{ bar} = 15 \times 10^5 \text{ N/m}^2$$

$$V = 1700 \text{ rev/min} = 28.33 \text{ rev/sec}$$

$$T = 175 \text{ N/m} \quad \text{Nominal displacement} = 100 \text{ cm}^3/\text{rev}$$

$$= 1 \times 10^{-5} \text{ m}^3/\text{rev}$$

~~Ideal flow rate - Given for~~

Volumetric Efficiency

$$\frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\% \quad \text{Ideal flow rate} = \text{displacement} \times \text{Speed}$$

$$Q = 1 \times 10^{-5} \times 28.33 \\ = 2.833 \times 10^{-4} \text{ m}^3/\text{sec}$$

$$\text{Volumetric Efficiency} = \frac{8.033 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100 \\ = 29.4\%$$

fluid power ( $Q \times \Delta P$ )

$$= 8.033 \times 10^{-5} \times 15 \times 10^5 = 124.95 \text{ watts}$$

Shaft power =  $T \times \omega$

$$\omega = 2\pi \times \text{rpm} = 2\pi \times 28.33 = 178 \text{ rad/sec}$$

$$= T \times \omega$$

$$= 15 \times 178 = \underline{2670 \text{ watts}}$$

Overall Efficiency

$$\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$$

shaft power

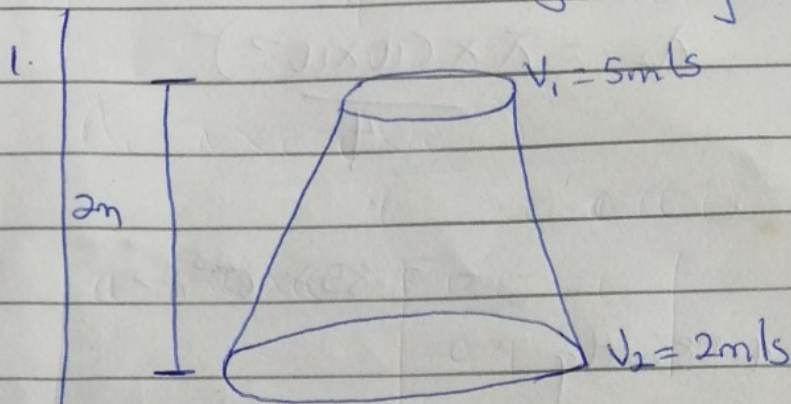
$$= \frac{124.95}{2670} \times 100$$

$$= \underline{\underline{4.68\%}}$$

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$$P_H = P_1/w = 2.05 \text{ m}$$

$$H_L = \frac{0.35(V_1 - V_2)^2}{2g}$$

Using Bernoulli's equation  $P/w = \rho$

$$P_1/w + V_1^2/2g + Z_1 = P_2/w + V_2^2/2g + Z_2 + H_L$$

$$P_2/w = P_1/w + \left[ \frac{V_1^2 - V_2^2}{2g} \right] + [Z_1 - Z_2] - H_L$$

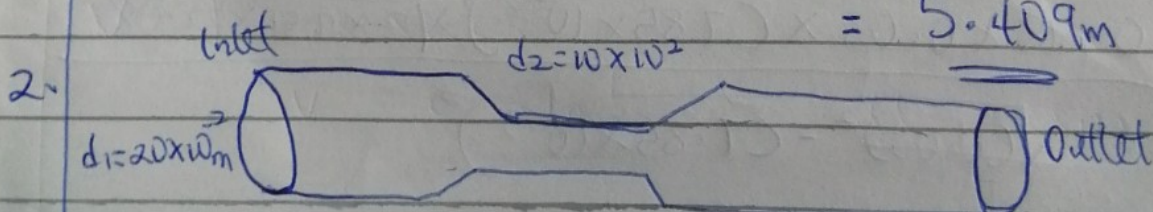
$$P_2/w = 2.05 + \left[ \frac{5^2 - 2^2}{2 \times 9.81} \right] + 2 - \frac{0.35(5-2)^2}{2 \times 9.81}$$

$$P_2/w = 2.05 + 1.07 + 2 - 0.161$$

$$P_2/w = 5.409 \text{ m}$$

$\therefore$  The pressure head at the lower end

$$= 5.409 \text{ m}$$



$$P_1 = 17.658 \text{ N/cm}^2 = 17.658 \times 10^4 \text{ N/m}^2$$

$$C_d = 0.98$$

$$P_2 = 30 \text{ cm Hg} = 30 \times 10^{-2} \text{ m Hg}$$

$$Q = ?$$

$$A_1 = \frac{\pi \times (20 \times 10^{-2})^2}{4}$$

$$= 0.03 \text{ m}^2$$

$$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08 \text{ m Hg}$$

$$\frac{P_2}{w} = -4.08 \text{ (Since vacuum pressure)}$$

$$\frac{P_1}{w} = \frac{17.058 \times 10^4}{4.81 \times 10^3} = 18$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08) = 22.08$$

$$Q = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$Q = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.03)^2 - (7.85 \times 10^{-3})^2}}$$

$$Q = 0.166 \text{ m}^3/\text{s}$$